North Atlantic

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The Northeast Utilities System

May 4, 2001

Docket No. 50-443

NYN-01041

CR# 01-02115

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Seabrook Station
Licensee Event Report (LER) 01-002-00 for
Reactor Trip Due to Power Arc Flashover Across
the "B" Phase 345 kV Transmission Line Bushings

Provided in Enclosure 1 is Licensee Event Report (LER) 01-002-00. This LER reports an event that occurred at Seabrook Station on March 5, 2001. This event is being reported pursuant to 10 CFR 50.73(a)(2)(iii) and 10 CFR 50.73(a)(2)(iv)(A). Enclosure 2 includes a list of North Atlantic Energy Service Corporation (North Atlantic) commitments made as a result of this LER.

Should you require further information regarding this matter, please contact Mr. James M. Peschel, Manager-Regulatory Programs at (603) 773-7194.

Very truly yours,

NORTH ATLANTIC ENERGY SERVICE CORP.

Ted C. Feigenbaum
Executive Vice President and
Chief Nuclear Officer

cc: H. J. Miller, NRC Region I Administrator
V. Nerses, NRC Project Manager, Project Directorate I-2
NRC Senior Resident Inspector

IE22

ENCLOSURE 1 TO NYN-01041

NRC FORM 366 (1-2001)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 6-30-2001

Estimated burden per response to comply with this mandatory information collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records Management Branch (T-6 E6), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

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TITLE (4)

Reactor Trip Due to Power Arc Flashover Across the "B" Phase 345 kV Transmission Line Bushings

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
03	05	01	01	- 002 -	00	05	04	01	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	1
POWER LEVEL (10)	100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply) (11)

	20.2201(b)		20.2203(a)(3)(ii)		50.73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
	20.2201(d)		20.2203(a)(4)	x	50.73(a)(2)(iii)		50.73(a)(2)(x)
	20.2203(a)(1)		50.36(c)(1)(i)(A)	x	50.73(a)(2)(iv)(A)		73.71(a)(4)
	20.2203(a)(2)(i)		50.36(c)(1)(ii)(A)		50.73(a)(2)(v)(A)		73.71(a)(5)
	20.2203(a)(2)(ii)		50.36(c)(2)		50.73(a)(2)(v)(B)		OTHER Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iii)		50.46(a)(3)(ii)		50.73(a)(2)(v)(C)		
	20.2203(a)(2)(iv)		50.73(a)(2)(i)(A)		50.73(a)(2)(v)(D)		
	20.2203(a)(2)(v)		50.73(a)(2)(i)(B)		50.73(a)(2)(vii)		
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50.73(a)(2)(viii)(A)		
	20.2203(a)(3)(i)		50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(B)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
James M. Peschel	(603) 773-7194

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B	BA	P	I075	Y					

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On March 5, 2001 at 2324, with the plant at 100% power, Seabrook Station experienced a plant trip during a severe winter storm. Prior to this event, the plant was experiencing difficulty with the off-site power supplies to the plant. At 2238 on March 5, 2001, the 345 kV breakers for the Scobie line opened disabling one of the three off-site supplies. At 2248 on March 5, 2001, the 345 kV breakers for the Newington line opened disabling the second of three off-site lines. At 2324 on March 5, 2001, off-site 345 kV electrical supply via the Newington line was restored. However, the breaker alignment prevented this line from powering station buses. Shortly thereafter, the Tewksbury line tripped. Almost immediately after the trip of the Tewksbury line, a reactor trip occurred.

An unusual event was declared on March 5, 2001 at 2336 since the supply of off-site power was not considered reliable due to the adverse weather conditions. The unusual event was terminated on March 7, 2001 at 1046 when offsite power was restored to emergency Bus 5. The State of New Hampshire, the Commonwealth of Massachusetts and the Nuclear Regulatory Commission were notified of the event.

The cause of the event is power arc flashover from the line to ground across the "B" phase 345kV bushings that connect the sulphur hexafluoride (SF6) gas insulated 345 kV bus sections to the 345 kV overhead lines. The power arc flashover was due to the severe weather conditions and subsequent buildup of snow on the "B" phase bushings, which exceeded their capability. The consequences of this event were minimal. However, certain components did not operate as expected. Corrective actions have been identified to prevent recurrence.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

I. Description of Event

On March 5, 2001 at 2324, with the plant at 100% power, Seabrook Station experienced a plant trip during a severe winter storm. Prior to the trip, the plant was experiencing difficulty with the off-site power supplies [FK] to the plant as a result of the storm. At 2238 on March 5, 2001, the 345 kilo-volt (kV) breakers for the Scobie line opened disabling one of the three off-site supplies. At 2248 on March 5, 2001, the 345 kV breakers for the Newington line opened disabling the second of three off-site lines. At 2324 on March 5, 2001, off-site 345 kV electrical supply via the Newington line was restored. However, the breaker alignment prevented this line from powering station buses. Shortly thereafter, the Tewksbury line tripped. Almost immediately after the trip of the Tewksbury line, a reactor trip occurred.

An unusual event was declared on March 5, 2001 at 2336 since the supply of off-site power was not considered reliable due to the adverse weather conditions. The State of New Hampshire and the Commonwealth of Massachusetts were notified of the unusual event at 2347 on March 5, 2001. The Nuclear Regulatory Commission (NRC) was notified of the unusual event and reactor trip (Event Number 37810) at 0024 on March 6, 2001 pursuant to the requirements of 10 CFR 50.72(a)(1)(i) and 50.72(b)(2)(iv)(B). Subsequent notifications were made to the NRC at 0222, 0438, 0800, 1509, and 1619 on March 6, 2001 to provide updates on the plant condition. The unusual event was terminated on March 7, 2001 at 1046 when offsite power was restored to emergency Bus 5. At 1048 on March 7, 2001, the State of New Hampshire and the Commonwealth of Massachusetts were notified that the unusual event had been terminated. The NRC was subsequently notified of the termination of the unusual event at 1055 on March 7, 2001. This event is being reported pursuant to the requirements of 10 CFR 50.73(a)(2)(iii) due to the existence of an external condition (the storm) that caused an actual threat to the safety of the plant and 10 CFR 50.73(a)(2)(iv)(A) as a result of the automatic actuation of the reactor protection system and emergency feedwater system.

Based upon a review of the event, immediately prior to the reactor trip, as the last off-site line isolated, the main generator frequency increased slightly above 62 hertz. The main turbine Electrohydraulic Control System (EHC) [TG] quickly functioned to restore main generator [EL] speed to 1800 revolutions per minute (rpm). As a result, reactor coolant flow increased by just over 4% and then decreased. This change in rate caused the bistables for 2 of the 4 power range channels [JD] to trip, which resulted in a reactor trip.

Following the reactor trip, the rods fully inserted. Both emergency diesel generators [EK] automatically started and loaded providing power to the emergency electrical buses [EB]. As a result of the electrical transient, the power supplies to non-vital loads [EA] in the plant were isolated, including the reactor coolant pumps and the circulating water pumps. A reactor coolant pump was restarted shortly thereafter at 0007 on March 6, 2001 after power was restored to the non-vital buses.

Additionally, during a review of the post reactor trip data it was identified that the "A" power operated relief valve (PORV) cycled five times over a period of 3.3 seconds. The valve cycling of the "A" PORV occurred because the circuitry for the valve is anticipatory. If reactor coolant system [AB] pressure is increasing and approaches the setpoint, the circuit will speed up the signal and open the valve prior to actually reaching its 2385 psig setpoint. There was no indication that pressure increased to 2385 psig. The "B" PORV actuates as a result of direct pressure input only, and did not reach its setpoint. The actual pressure recorded was 2355 psig.

As a result of this event, certain components did not operate as expected. These components are identified as follows:

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

Startup Feed Pump Supply Breaker

While non-vital bus 4 was de-energized, the supply breaker to the Start-Up Feed Pump (FW-P-113) cycled open and closed 18 times for a period of 24 minutes. Plant operators placed the control switch for the pump in the pull-to-lock position in accordance with the Reactor Trip Response procedure and the cycling of the breaker ceased.

Main Steam Isolation Valve (MS-V90)

In order to perform a controlled cooldown of the reactor coolant system utilizing the atmospheric steam dump valves, plant operators manually attempted to close the main steam [SB] isolation valves (MSIVs) at 2343 on March 5, 2001. Three of the four MSIV's closed as expected. The fourth MSIV did not respond and was subsequently closed at 2347 on March 5, 2001, when the plant operators manually initiated a main steam line isolation signal.

EFW Turbine Driven Pump

Due to a Lo-Lo level condition in the steam generators as a result of the reactor trip, an automatic initiation of the emergency feedwater system (EFW) [BA] occurred resulting in a start of both safety-related EFW pumps. Approximately 30 seconds after the start of the turbine driven EFW pump (FW-P-37A) the pump tripped due to an apparent overspeed condition. There was no immediate attempt to restart FW-P-37A because the redundant motor driven EFW pump (FW-P-37B) was operating and supplying the required feed flow to the steam generators. Feedwater supply [SJ] to the steam generators was subsequently transferred to the Startup Feedwater pump (FW-P-113) at 0136 on March 6, 2001. A subsequent internal investigation of the pump was also performed. This investigation identified that that there was some evidence of contact between the rotating and stationary elements.

II. Cause of Event

"B" Phase 345kV Bushings

The cause of the event is power arc flashover from the line to ground across the "B" phase 345kV bushings that connect the sulphur hexafluoride (SF6) gas insulated 345 kV bus sections to the 345 kV overhead lines. The power arc flashover was due to the severe weather conditions and subsequent buildup of snow on the "B" phase bushings, which exceeded their capability.

A contributing cause was the failure to correct the cause of a similar bushing flashover event that occurred in 1997. The root cause analysis for the 1997 event correctly identified that the primary cause of flashover was a buildup of snow on the bushing. However, corrective actions to prevent recurrence focused on a contributing cause regarding the reduction in clearance between the line conductor and the bottom bushing corona ring.

Startup Feed Pump Supply Breaker

The cause of the cycling of the Startup Feed Pump supply breaker is inadequate design. During a plant trip, the Startup Feed Pump receives a start demand signal when both Main Feed Pumps trip. If the breaker's power supply from non-vital bus 4 is de-energized, the breaker immediately trips open. This process repeats until the bus is re-energized or plant operators manually take the control switch to the Pull-To-Lock position.

Main Steam Isolation Valve (MS-V90)

The failure of MS-V90 to close utilizing the non-safety related slow close feature from the control room was caused by a bad connection to the field buffer board.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

EFW Turbine Driven Pump

The cause of the pump overspeed was incorrect alignment of the pump rotating assembly. This was due to vague and incorrect guidance in the pump vendor manual, an inadvertent deletion of a step in the maintenance procedure verifying that no rubs are present during alignment, and inadequate validation of verbal information supplied by the vendor. The improper alignment of the pump shaft occurred during a pump shaft replacement in a previous outage. This misalignment caused internal binding, which slowed the impeller. The steam turbine governor responded to the change in speed by increasing steam supply to the turbine. As the rub broke free a momentary overspeed condition resulted. This overspeed condition resulted in an actuation of the turbine overspeed trip mechanism, which isolated steam to the turbine. The pump was subsequently tested by admitting steam to the turbine and the pump rolled with no rubbing or binding.

III. Analysis of Event

There were no radiological consequences as result of this event. This event is significant in that multiple plant components were challenged. However, the risk significance of this event was minimal. The event specific change in core damage frequency was 1.27e-7. The reactor protection system responded as designed and the rods fully inserted. Both emergency diesel generators automatically started and loaded providing power to the emergency electrical buses as designed for a period of approximately 35 hours after the initiation of the event. During this event, at least one off-site source of power remained available to the site. Off-site power was restored to non-vital buses 1, 2, 3, and 4 within 31 minutes after the plant trip utilizing the Reserve Auxiliary Transformers.

The primary function of the 345 kV switchyard and distribution system is to connect the station electrical system to off-site power grid. This connection permits the normal flow of power out of the station when the main generator is operating. Additionally, this connection allows the flow of power from the grid to station electrical buses when the main generator is shutdown. The transmission grid connections that provide offsite power to Seabrook Station consist of three 345 kV transmission lines. The three transmission lines are connected to the switching station by metal enclosed SF6 insulated buses running between the line terminating yard and the switching station. The SF6 buses are protected by differential relays. These relays provide protection in the event of a fault on any one of the SF6 lines. When a fault is sensed, the differential relay energizes a lockout to the line circuit breakers and isolates the fault. The relay system functioned per design during this event.

The EFW system provides the capability to remove heat from the reactor coolant system during emergency conditions when the main feedwater system is not available. The Turbine Driven EFW pump will additionally operate to satisfy station blackout requirements.

The overspeed trip of the Turbine Driven EFW pump was significant from an equipment reliability point of view. The purpose of this pump is to supply feedwater to the steam generators. During this event, when the Turbine Driven EFW pump tripped, the Motor Driven EFW pump remained operable and provided the necessary feedwater flow until the Startup Feedwater pump was aligned for this purpose. Additionally, a post event review concluded that despite the overspeed trip, the Turbine Driven EFW pump could have been made available if needed. The ability to recover this pump was confirmed via both a short pump run and subsequent inspection by the pump vendor. The Motor Driven EFW pump supplied feedwater to the steam generators during this event. In addition, the Startup Feed Pump was available to supply feedwater.

The Startup Feed Water pump is used to supply feedwater to the steam generators during plant startup and shutdown conditions when feedwater requirements are low. The Startup Feed Water pump can be additionally used as a backup EFW pump, if required. The pump motor is normally powered from non-vital bus 4. The pump motor is capable of being powered from emergency bus 5, if required.

The cycling of the Startup Feed Water pump supply breaker was not safety significant. Excessive cycling of the breaker could have damaged it and prevented the pump from being powered from its non-vital power supply. However, the Startup Feed Pump was capable of being powered from its alternate safety related power supply, if required. The subject breaker was subsequently closed without incident when the Startup Feed Pump was placed into service approximately two hours after the plant trip.

Each main steam line contains one MSIV to provide positive shut-off of steam flow during emergency as well as normal operation. Each MSIV is normally operated from the control room utilizing the slow closure mode of operation. Alternatively, the valves are capable of closure within 5 seconds when a main steam isolation signal is manually initiated. The failure of MS-V90 to close utilizing the normal non-safety-related slow close control switch was not safety significant. Plant operators subsequently closed MS-V90 by actuating a main steam isolation signal. The valve closed as designed in response to the signal.

IV. Corrective Action

"B" Phase 345 kV Bushings

1. An Operations Department standing order was issued to establish periodic visual monitoring of the subject bushings during certain adverse weather conditions and to provide additional guidance in the event that a 345 kV line trips.

2. A walkdown of the switchyard and termination yard to verify system integrity was performed. The walkdown confirmed no structural concerns.

3. The 345 kV bushings on the Newington and Tewksbury lines were inspected. The inspections did not identify any problems with the sheds on the sidewall that could affect bushing performance.

4. Infrared thermography was performed on the 345 kV bushings. No hot spots were identified.

5. The nine 345 kV bushings that connect the SF6 gas insulated 345 kV bus sections to the 345 kV overhead lines were cleaned.

6. North Atlantic will evaluate the need for a design change to replace the existing 345 kV bushings with bushings that have improved capability to withstand severe weather conditions.

Startup Feed Pump Supply Breaker

7. North Atlantic will evaluate the need for a design change to prevent the Startup Feed Pump from cycling during the described conditions.

8. An inspection of the Startup Feed Pump supply breaker was performed and no adverse conditions affecting breaker operation were identified.

Main Steam Isolation Valve (MS-V90)

9. The field buffer board for MS-V90 was removed, cleaned and reinstalled. There were no obvious problems noted. The board was retested and performed as expected. Additionally, the boards and cabinets for the other thee MSIVs were inspected with no problems noted.

EFW Turbine Driven Pump

10. The rotating assembly for FW-P-37A was replaced.

11. The alignment of the redundant Motor Driven EFW pump (FW-P-37B) was verified to be correct.

12. The maintenance procedure, which centers the pump rotating assembly, will be revised to provide consistent repeatable results and steps for verification of rotor centralization and to verify that there are no pump rotor rubs after alignment.

13. The pump was retested and the governor response was verified.

14. The policy on vendor technical assistance will be revised to include additional guidance on the use of vendor supplied information.

V. Additional Information

None

Similar Events

This is the first event of this type reported by Seabrook Station. A bushing flashover was experienced during a similar storm in 1997. However, this did not result in a loss of power to station buses.

Manufacturer Data

Ingersoll Rand Centrifugal Pump, Model Number 4X9 NH 10

ENCLOSURE 2 TO NYN-01041

North Atlantic Commitments Contained in NYN-01041

Condition Report	Description of Commitment
01-04070	North Atlantic will evaluate the need for a design change to replace the existing 345 kV bushings with bushings that have improved capability to withstand severe weather conditions.
01-04070	North Atlantic will evaluate the need for a design change to prevent the Startup Feed Pump from cycling during the described conditions.
01-04070	The maintenance procedure, which centers the pump rotating assembly, will be revised to provide consistent repeatable results and steps for verification of rotor centralization and to verify that there are no pump rotor rubs after alignment.
01-04070	North Atlantic will revise the policy on vendor technical assistance to include additional guidance on the use of vendor supplied information.